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Research and Design Handle Temperature Camera

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ABSTRACT

Thermal cameras are useful devices that are used in many different situations, such as quality control, system maintenance, structural repair, security, medical, monitoring, treatment and diagnose human health or to research and develop advanced technological components. It provides visual temperature information that cannot be perceived by the human senses. Gade & Moeslund (2014) specified that Thermal cameras are passive sensors that capture the infrared radiation emitted by all objects with a temperature above absolute zero. This type of camera was originally developed as a surveillance and night vision tool for the military, but recently the price has dropped, significantly opening up a broader field of applications.

Our study shows With basic functions that can be used such as non-contact body temperature measurement, maintenance, maintenance, quality inspection and repair of electronic, electromechanical, telephone, chip, IC, over temperature detection, electrical system lines, underground cables, recessed walls, utilities, gas leak detection, ventilation furnaces, fireplaces, etc., the device can be a useful and effective civil tool.

***Keywords:** Thermal cameras, Infrared, Handheld thermal camera, Temperature, Infrared heat, Thermomechanical, Non-contact body temperature measurement, Electronic equipment.*

1. Introduction

Nowadays, The outstanding ability of infrared thermal cameras is to capture images and temperatures in areas of light that are invisible to the human eye, so its applications are diverse, in many fields such as security monitoring, fire detection, medical, long-distance non-contact body temperature measurement, maintenance, maintenance, inspection, repair, warning of thermomechanical, electrical, electronic equipment, etc.

In order to be able to monitor, measure and capture temperature zones, there are many supporting thermal camera products on the market from many reputable suppliers, such as the German Testo 868 device with high accuracy. 19200 pixel resolution, measuring range 30°÷650°C; Luke PTI120 can measure from -20°C÷150°C, 10800 pixels; Fluke TIS20+ measuring range -20°C÷150°C, 76800 pixels; CA 1954 with monitoring area -20°C÷+250°C, 19200 pixels; FLIR E5-XT measuring range –20°C÷400°C, 19200 pixels, etc. The common feature of commercial products is the variety of features, resolution, accuracy, style, range of applications, etc., but the price is too high, not suitable for personal research, common in civil use, cannot be reconfigured by programmers due to copyright factors, locked chip loading, etc. In addition, the researchers also published many works on the applicability of thermal cameras such as: Calibration of low-resolution temperature images for human temperature monitoring applications, detection systems, etc. dynamic use of artificial intelligence based on thermal imaging provides a urine flow measurement to assess urinary tract severity (A. Naser, A. Lotfi and J. Zhong, 2022).

Next Szajewska (2017) pointed that Cameras designed for firefighting and rescue operations are built on matrices of uncooled bolometric detectors sizes from 120x120 to about 320x240. Matrices containing 320x240 point detectors provide a sufficiently high resolution thermal image. Temperature resolution is 0.05°C. Cameras work in the long-term spectral range LW (8-14μm). This range includes infrared radiation, which is emitted by a man (about 9μm). Therefore they can be successfully used for locating the victims of fires. The long-term range

provides good visibility in heavy smoke conditions. Attenuation of radiation in the smoke (aerosol) depends on the absorption and scattering. The absorption depends on the chemical composition of the gas fire, for which we have no influence. Diffusion depends on the ratio of the effective diameter of the aerosol particles to the radiation wavelength. The diameters of smoke particles typically have a size of about 0.01 microns to about 1 micron.

Realizing the importance of temperature, as well as the applicability of thermal cameras, the authors have researched and deployed. This paper will research to build a compact device that allows temperature monitoring and acquisition of pixels reflecting the area. The product is designed to be low cost, reprogrammable to change, upgrade and modify according to the set goals.

1.1. Research questions

Question 1: Present previous related studies?

Question 2: What are applications of thermal cameras?

Question 3: What are experimental results of study?

2. Literature Review

2.1. Previous studies

Altay et al (2022) pointed that Visible-range camera sensors have been widely used for pedestrian detection. However, most of the methods, which employ visible-range color cameras, do not perform well under low-light and no-light conditions, e.g. during night time. Since the working principle of thermal camera sensors is mainly based on temperature and not light, they have been employed for person detection to overcome the drawbacks of visible-range sensors under these conditions.

Every object gives off thermal energy, which is captured by a thermal camera sensor. When an object becomes hotter, it emits more thermal energy, and is therefore captured as much brighter or vice versa. Yet, compared to visible-range cameras, there are many additional challenges that need to be addressed when detecting pedestrians from thermal camera images.

These challenges include bright hot objects close to humans, similar pixel values in an image due to weather conditions, or objects that block thermal cameras such as concrete or glass. Glass acts like a mirror for infrared radiation and reflects whatever is in front of the camera. Thus, novel methods are still required to accomplish pedestrian detection task from thermal camera images. To contribute to these efforts, we propose a new method and a modified object detection network incorporating saliency maps of thermal camera images. The features obtained from thermal images and their corresponding saliency maps are combined to obtain richer representations of pedestrian regions, and better detection performance.

Authors perform extensive evaluations on five different datasets to compare the performance of the proposed approach with two baselines. Then, study compares the transferability of these approaches by doing leave-one-out cross validation across different datasets. The results show that the proposed approach outperforms the baselines, and has better transferability properties across different thermal image datasets.

Next we consider below table:

Table 1. Summary of related studies

Authors	Year	Content, results
Gade & Moeslund	2014	Thermal cameras are passive sensors that capture the infrared radiation emitted by all objects with a temperature above absolute zero. This type of camera was originally developed as a surveillance and night vision tool for the military, but recently the price has dropped, significantly opening up a broader field of applications. Deploying this type of sensor in vision systems eliminates the illumination problems of normal grayscale and RGB cameras. This survey provides an overview of the current applications of thermal cameras. Applications include animals, agriculture, buildings, gas detection, industrial, and military applications, as well as detection, tracking, and recognition of humans. Moreover, this survey describes the nature of thermal radiation and the technology of thermal cameras.
Kim et al.	2015	Thermal Imaging Camera (TIC) is a device that supports putting out fires. Firefighters appreciate such devices and their usage constantly increases. TIC facilitates the work, increases the safety of rescuers, contributes to the rapid and efficient conduct of the action, can reduce the consumption of extinguishing agents and reduces fire losses.
Parent et al.	2010	TIC is most commonly used for fighting fires in buildings. It is also used in other activities, such as combating the effects of natural disasters and catastrophes, searching for missing persons, carrying out the evacuation of people and animals in the darkness, smoke and fog. TIC is also a part of the equipment of robots designed for rescue actions in smoky and foggy conditions. TIC may be used to measure IR radiation emitted during a vegetation fire.
Szajewska	2017	Presented the history of the development of Thermal Imaging Camera (TIC) in fire protection. It also includes the advantages of such cameras and how to use them. Manufacturers have developed cameras adapted to the needs of fire service units. Such cameras are easy to operate and suitable for harsh fire conditions.

		The cameras are usually used during extinguishing fires in buildings. They are useful primarily to assess the fire situation, detect the sources of ignition and search for fire victims.
Saikh et al.	2019	While the literature review reports of extensive study of thermal imaging as subordinate tool for disease diagnosis, it cannot be denied that there still is dearth of standard thermal image databases of human body with medical conditions characterized by elevated temperatures in affected body parts which could be a useful research aid. This could be attributed to the highly expensive Thermal Imagers commercially available. Therefore attempts to design and develop a reliable and cost-effective thermal sensor could be a pragmatic step towards widespread availability of thermal imaging device for use in medical applications. In this Paper, we have attempted to review the research works which has reported application of thermal imaging for medical purposes. We have also summarized the thermal imagers used and the temperature range and resolution of thermal sensors utilized in their reported works.
Caliwag et al.	2021	The rapid growth of the current pandemic (Covid-19) requires the use of thermal cameras that can perform fast and automatic body temperature measurement. The accuracy of the temperature measurement is affected by its distance from a person. Conventional distance estimation methods utilize the coordinates of the bounding box provided by several face detection algorithms such as YOLOv3 and SSD. The bounding box output of these methods varies which causes inaccurate distance estimation results. In this study, we propose a distance estimation method for thermal camera applications based on the coordinates of the facial key points extracted using multi-task cascaded convolutional neural network. The result obtained in this study proves that the proposed method exhibits higher accuracy (root mean square error of 2.9695 cm in comparison with an RMSE of 25.26 cm using other methods) and the least CPU and memory consumption in comparison with conventional methods.

(Source: author analysis and synthesis)

Beside, Thermal camera is considered as the arm of industries in fields such as: security, electrical inspection and repair, mechanics, in medicine, etc products that help users optimize time as well like work efficiency.

Thermal camera is also known as thermal camera, infrared camera. They use infrared radiations to capture thermal areas, then save and display them as a color palette corresponding to the temperature level. Products are widely applied in human activities.

In security: this device helps users to observe at night with a defined area. This device supports intrusion detection without the need for auxiliary lighting. Wide areas using this equipment include: Airports, businesses using outdoor display products such as cars, boats, etc. In fire control: This device supports object tracking over a wide operating range, making it easy for users to detect fire and explosion alarm points easily. In law enforcement: this device supports detecting illegal activities at night such as smuggling, theft, etc. In maritime security: Thermal cameras help users in patrolling, detecting and avoiding identified obstacles at sea. In temperature measurement: This device is used in monitoring production processes and used in monitoring automation systems.

2.2. Methodology

In this research, analytical method is used with data from a Vietnam case and this is an experimental model, and we also test the products and results are real examples in Vietnam.

This paper uses mainly description, qualitative analysis and analytical and synthesis methods. We also use observations and experiences, design and practical experiments.

3. Main Findings

3.1. Design experiments

The device is built as a block diagram as shown in Figure 1, it has the function of measuring infrared temperature without contact, the screen shows the obtained value and the color zones corresponding to the area with the highest temperature. has a white light color, the average temperature is shown in orange and yellow, and the lowest temperature is shown in blue or purple.

- Input block: A switch as shown in Figure 1 (a) to turn on and off the power supply with contact resistance ≤ 20 MΩ, insulation ≥ 100 MΩ and buttons in Figure 1 (b) to install the device, is a PBS type -110, NC, capacity 250V1A AC, resistance 100 M.

(a) (b) (c) (d)

Fig.1. (a) Power switch; (b) Push button; (c) OLED display; (d) Sensor AMG8833

- Display block: Display parameters to 0.95inch OLED screen [8] as shown in Figure 2 (c), resolution: 96 x 64, 65536 colors, SPI communication, voltage 3.3V ÷ 5V.

- Sensor block: Using AMG883 thermal infrared sensor [9] in Figure 2 (d), measuring range 0°C ÷ 80°C, error ± 2.5°C, supply voltage 3.3V ÷ 5V, speed Maximum frame rate 10Hz, I2C communication.

MEJAST

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- Central processing block: Using Arduino Nano board (Lampiran, 2020) as shown in Figure 2 (a) with AVR ATmega328P-AU MCU core, supporting digital, analog I/O signals, UART, SPI, I2C communication, with refactorable, loaded with the Arduino IDE.

- Power block: Provide DC power for the system, can use 9V battery as shown in figure 2 (b) or 3.3V ÷ 9V adapter.

(a) (b)

Fig.2. (a) Power switch; (b) Push button; (c) OLED display; (d) AMG883 sensor

3.2. Experimental results

Connecting peripheral components including power switch, 3 buttons (Menu, Up, Down), Oled display, IR infrared thermal sensor AMG8833 with Arduino nano, 9V battery supply according to the principle circuit as shown in Figure 4 and connect the pins as shown in Table 1. The product after being built, installed the electronic devices, connected the wires, loaded the program into the microcontroller and boxed up has the shape as shown in Figure 4(a) and Figure 4(b).

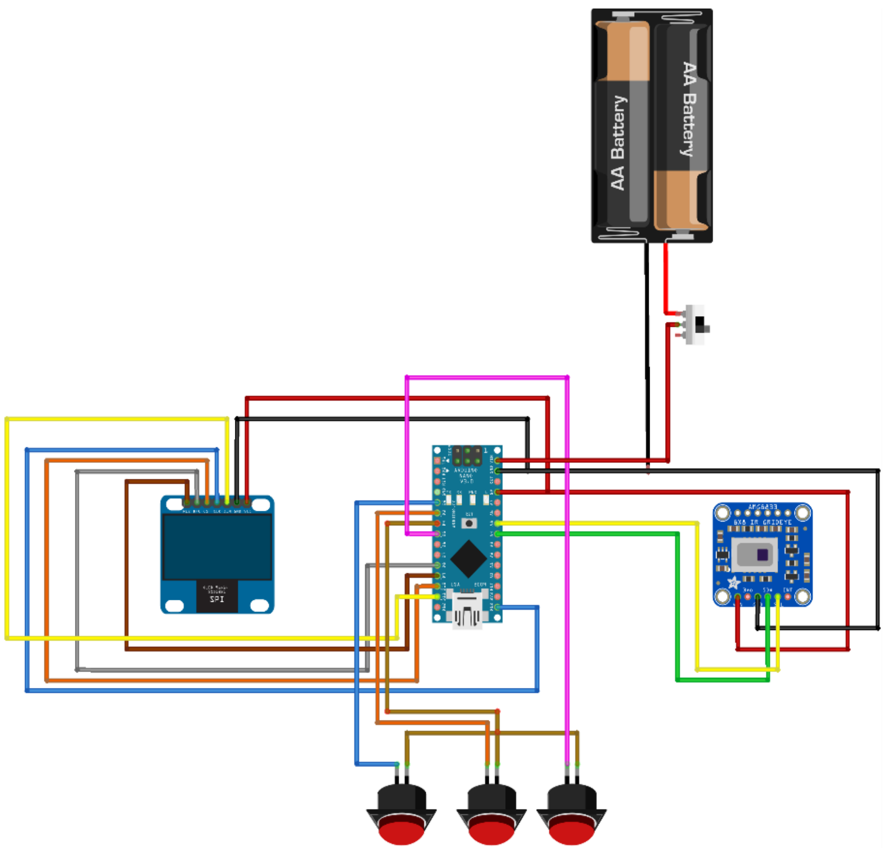
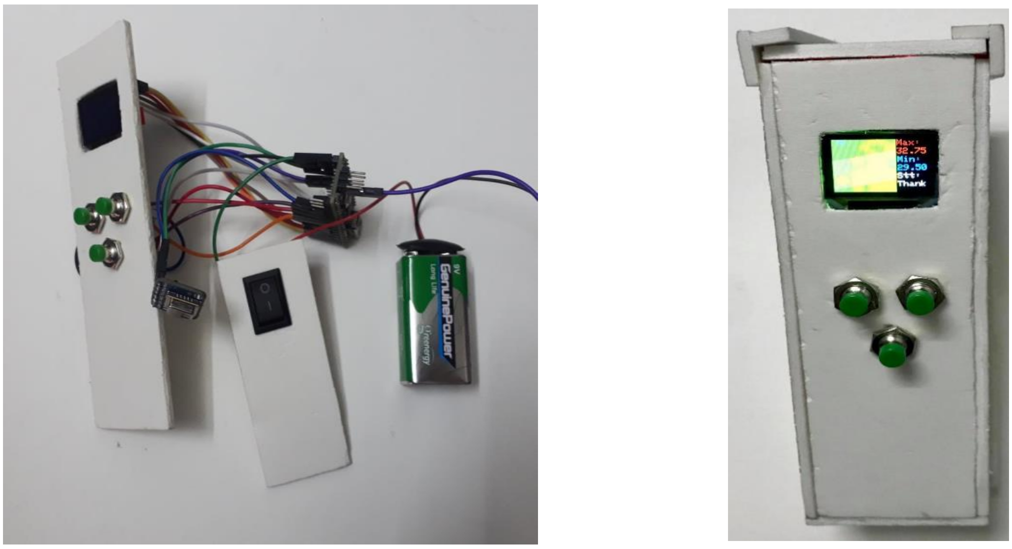


Fig.3. Hardware connection circuit of electronic components of thermal camera

Table 2. Connecting pins between Arduino and Oled and AMG8833

Arduino Nano	Oled	AMG8833
GND	GND	GND
VCC	5V	Vin
D13	SCL	
D11	SDA	
D9	RES	
D8	DC	
D10	CS	
A5		SCL
A4		SDA

When the power switch is turned on, the display screen will pixel, color code and corresponding temperature within the monitoring range of the AMG8833 sensor receiver within a range of less than 7m onto a 0.95 inch screen. When you need to set the pixels, increase or decrease, press the Menu button and the Up and Down buttons respectively. Depending on the temperature in the area received from the sensor, the value goes up, the message and the corresponding color areas go up Oled.



(a) (b)

Fig.4. (a) Construction and connection of electronic components; (b) Finished handheld mini thermal camera

4. Conclusion and Recommendation

Temperature is an important factor in all fields of science, production, living, etc. related to matter as well as human health. Measurement, monitoring and alarms with temperature values, images, and colors are essential.

The device developed from the research can measure and display the color area corresponding to the temperature received in the detection area of the sensor eye. With a compact, portable design, it is possible to set the temperature

area (upper and lower thresholds) to be surveyed, the resolution to be displayed on the oled screen, convenient to carry, the product of the project can be used. Even in the absence of light, applications can include: Non-contact body temperature measurement, maintenance, maintenance, quality inspection and repair of electronic, electromechanical and electrical equipment telephone, chip, IC, power system line overheating detector, underground cable, wall, electricity and water, gas leak detection, furnace ventilation, heater, etc..

5. Research limitation

Study can expand for other practical applications with more experiments.

Declarations

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Competing Interests Statement

The authors declare no competing financial, professional and personal interests.

Consent for publication

Authors declare that they consented for the publication of this research work.

Authors' Contributions

All authors equally contributed in experimentation and paper drafting.

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